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CARL L. ALSBERG, CHIEF OF BUREAU.

THE COMPOSITION OF DIFFERENT VARIETIES OF RED PEPPERS.

BY

L. M. TOLMAN AND L. C. MITCHELL,
Food Inspection Laboratory.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Chemistry,
Washington, D. C., November 11, 1912.

Sir: I have the honor to transmit for your approval the results of a study of the best known commercial varieties of red peppers. The purpose has been to determine the normal composition of each variety in order to learn the characteristic properties of each part and in order to be able to detect the presence of abnormal amounts of seeds and stems. The results have shown the impracticability of having a single standard for the various kinds.

I recommend that this report be published as Bulletin 163 of the Bureau of Chemistry.

Respectfully,

R. E. Doolittle,
Acting Chief.

Hon. James Wilson,
Secretary of Agriculture.

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THE COMPOSITION OF DIFFERENT VARIETIES OF RED PEPPERS.

PURPOSE OF THE STUDY.

The results of a study of nearly all the commercial varieties of red peppers, including the African and the Japanese cayenne or chillies, the Hungarian paprika, and the Spanish pimenton, or pimiento, have been considered in this article. The plan of the work has been to determine the normal composition of these various kinds of red peppers, with special regard to the variations in ash, sand, ether extract, crude fiber, etc., in the normal product and also to study the characteristic odor, flavor, taste, and other properties, in order to show to what part or parts of the fruit these characteristic properties are due.

Another object of the work has been to determine the effect on the composition of the ground pepper of the inclusion or exclusion of seeds or stems, in order to be able to detect their presence or absence.

This work was undertaken because the present standards have been criticized as not applying to all varieties of these peppers and because it is apparent from the work of this laboratory that each kind or variety must be judged by comparison with data obtained on its own variety. Especially is this true in the case of the African and Japanese chillies and of the Spanish pimenton and Hungarian paprika as regards their ash and sand content.

It appears that climatic and cultural conditions undoubtedly have a great effect not only on the quality of the pepper but also on the amount of sand or ash which may be present.

METHODS OF ANALYSIS.

MOISTURE.

Dry 2 grams at 70° C. in vacuo to constant weight.

ASH.

Determine as directed on page 162, under 3, Bureau of Chemistry, Bulletin 107, Revised (an electric muffle at low red heat was used).

ASH INSOLUBLE IN ACID.

Determine as directed on page 162, under 5, Bureau of Chemistry, Bulletin 107, Revised.

ETHER EXTRACT, VOLATILE AND NONVOLATILE.

Determine as directed on page 163, under 9, Bureau of Chemistry, Bulletin 107, Revised, except that the extraction is carried on for 24 hours instead of 16.

CRUDE FIBER.

Determine as directed on page 56, under 11, Bureau of Chemistry, Bulletin 107, Revised.

EXAMINATION OF THE OIL. (SEEKER'S METHOD.)

Preparation.—Spread 5 grams of paprika on a watch crystal and dry over sulphuric acid for at least 12 hours. Measure 250 cc of anhydrous alcohol-free ether, prepared as directed on page 39 of Bulletin 107, Revised, into a graduated flask on which the mark is situated near the lower end of the neck, and brush the paprika into it. Place a mark on the neck of the flask at the point where the meniscus is and allow to stand for 1 hour, shaking at 20-minute intervals during that time. Bring the meniscus back to the mark upon the neck, either by cooling the flask and contents if the level has risen, or by adding absolute ether if it has fallen. Let the solid particles settle, pipette off 100 cc of the supernatant liquid, and filter this through an 11 cm closely woven paper into a tared, air-dry 250 cc Erlenmeyer flask (glass stoppered) that has been counterpoised against a similar flask. Wash the paper with a little absolute ether and then distill off the solvent, removing the flask from the bath as soon as the ether ceases to come over. Lay the flask on its side in a water oven and heat for 30 minutes; cool the open flask for at least 30 minutes in the air and weigh. Repeat this heating and weighing until the weight is constant to within 1 mg, two heatings usually being sufficient. Note the percentage of ether extract obtained.

This method gives a lower amount of nonvolatile ether extract than the continuous extraction method; the average results as shown in Tables 3 and 7 give from 1 to 2 per cent lower ether extract by this method.

Iodin number.—Dissolve the ether extract in the flask with 10 cc of chloroform, and when the solution is complete add 30 cc of Hanus solution, following the method on page 137, Bulletin 107, Revised, and allowing 30 minutes for the halogen absorption. Note the iodin number of the ether extract. A second aliquot of 100 cc, measured out immediately after the first, may be taken from the ether extract in the graduated flask in order to run a duplicate determination of the iodin number. If it is found necessary to heat the ether extract longer than one and one-half hours to obtain constant weight, or if the extract is decolorized on heating, the determination should be rejected and a new one made, using freshly purified ether.

Index of refraction.—Determine at 40° C., as described on page 131, Bulletin 107, Revised, Bureau of Chemistry. (The oil is prepared as above.)

CAYENNE, OR CHILLI.

GENERAL DESCRIPTION.

Cayenne or chilli is a small fruited pepper, a variety of *Capsicum frutescens* L., a species of *Capsicum*, which is a genus of the family Solanaceæ, indigenous to the American tropics, but now grown or cultivated in nearly all tropic and subtropic countries. It is characterized by its extreme pungency and the small size of the pods. The leading commercial varieties (1911) are African and Japanese.

The African cayenne or chillies come chiefly from the ports of Mombasa and Zanzibar, British East Africa, and are usually designated in the trade by the name of the port from which shipped; they are from 10 to 15 mm in length, dark, dull red in color, and extremely pungent; they are ground for use. A few of the samples contained some unattached stems and calyxes.

The Japanese chillies come from the port of Kobe, Japan; these are from 15 to 40 mm in length, bright red in color, clean, containing very few stems or calyxes, and are used chiefly in the unground condition for the preparation of the so-called "chilli sauce."

Cayenne or chilli contains a fixed, bland oil, found in both pods and seeds, but more abundantly in the latter, considerable resinous and mucilaginous material, a red coloring matter confined to the shell, and the active principle, capsaicin, to which the pungency is due. The capsaicin is present in both the seeds and the shell, but the larger part is found in the placentæ. The red coloring matter is soluble in ether, petroleum ether, carbon bisulphid, and chloroform, but very slightly soluble in alcohol.

ANALYSES.

In addition to the African and Japanese varieties which make up the major portion of the importations, two other apparently different varieties were examined. N. Y. 25482 is a nearly round cayenne or chilli from India, 15 to 25 mm in length and 10 to 15 mm in width, belonging to *C. frutescens baccatum* L., and known to the trade under the name "cherry." The color of the pods varies from dark red to a brownish yellow; the sample was clean and had no stems or calyxes. B. 4484 is a capsicum from Japan and is from 45 to 65 mm in length, bright red in color, clean, and had the stems and calyxes attached to the pods. Analysis indicates this to be a sweet red pepper.

In order to determine the characteristic taste and flavor and to find out definitely what part or parts of the pod contained the capsaicin, pods from different samples were broken up into the following parts: Shells, seeds, and placentæ. The shells from the Japanese

chillies have a slightly bitter, slightly acid, bland taste (similar to that of pimenton) and are mildly pungent; the seeds, a sweetish, bland, mildly pungent taste; and the placentæ extremely pungent, containing nearly all the active principle, capsaicin; the ground product has a very pungent taste. The shells from the African chillies have a slightly acid, pungent taste; the seeds, a sweetish, bland, pungent taste, and the placentæ, extremely pungent; the ground product has a very pungent taste.

All the N. Y. samples were taken by the regular United States Treasury samplers by means of coffee triers which were inserted into the packages or bales and the samples allowed to flow out into paper bags, from the various imports as they were received.

I. S. 3817–C was a portion of a composite sample taken from five original unopened bales, each bale being cut open lengthwise, and about 2 quarts taken with a scoop from approximately the center, all portions mixed, and a small portion of 1 or 2 quarts in volume taken, and again subdivided. A portion of the subdivision was used for analysis.

I. S. 3818–C was a portion of a composite sample taken from several bales, each bale being opened at the top and several handfuls taken from each, all mixed, and a small sample taken for analysis.

I. S. 3819–C was sampled by the same method as I. S. 3818–C.

I. S. 3820–C was sifted Mombasa pods. This sample consisted of a portion of a lot of Mombasa chillies representing 5 bales, weighing 715 pounds before sifting, and from which 5 pounds of dirt, principally sand, were removed by sifting.

I. S. 3821–C, siftings from Mombasa pods, described the same as I. S. 3820–C. This sample showed 62.63 per cent of ash and 51.53 per cent of sand.

I. S. 3822–C was a portion of a composite sample taken from 5 bales, each of which was split down the side and about a quart removed by a scoop from the center of the bale. A small portion of the composite sample mixed from all 5 bales was taken for analysis These goods represented the same invoice as described under I. S. 3820–C, but were unsifted and just as imported.

I. S. 3823–C was a composite of 4 bales, each of which was split down the side and a pound taken from each in the center by a scoop and all 4 pounds mixed together for analysis. The sample represented goods as imported in the original bales.

In Table 1 have been collected results of analyses of 27 samples of African or Mombasa chillies, 17 samples of Japanese or Kobe chillies, 1 sample of Indian or "cherry" chillies, 1 sample of sweet red pepper, and the ash and insoluble ash of 1 sample of siftings. In each instance, an analysis was made of the original and of the part which had been carefully sifted with an ordinary coarse 3 mm hand sieve to remove as much sand as possible. The two analyses are placed on the same line, so that a ready comparison may be made.

TABLE 1.—*Percentage results of analyses of chillies, or cayenne peppers.*

Serial No.	Original.						Sifted.					
	Total ash.	Ash insoluble in 10 per cent hydrochloric acid.	Sand-free ash.	Volatile ether extract.	Nonvolatile ether extract.	Crude fiber.	Total ash.	Ash insoluble in 10 per cent hydrochloric acid.	Sand-free ash.	Volatile ether extract.	Nonvolatile ether extract.	Crude fiber.
African (Mombasa) chillies or cayenne:	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
N. Y. 24584.	6.45	1.56	4.89	.....	17.91	26.41	5.98	0.82	5.16	.....	18.34	26.75
N. Y. 24605.	5.34	.44	4.90	.....	18.59	27.26	5.51	.46	5.05	.....	18.45	27.97
N. Y. 24606.	7.38	1.73	5.65	.....	17.70	28.45	5.71	.72	4.99	.....	18.60	28.11
N. Y. 24610.	7.44	1.03	6.41	.....	19.00	26.13	6.16	.72	5.44	.....	18.46	27.44
N. Y. 24701.	4.88	.45	4.43	0.24	19.36	25.26	4.80	.52	4.28	0.28	19.02	26.21
N. Y. 24802.	7.72	2.59	5.13	.41	16.43	27.25	5.80	.72	5.08	.47	16.41	27.22
N. Y. 24803.	.....	.....	.....	.....	.....	.....	5.51	.52	4.99	.74	17.03	28.81
N. Y. 24855.	5.81	1.00	4.81	1.21	18.60	27.39	5.71	.64	5.07	.85	18.63	27.63
N. Y. 24885.	5.48	.55	4.93	.89	18.60	27.86	5.18	.44	4.74	1.11	18.14	28.03
N. Y. 25027.	5.51	.78	4.73	.51	16.81	26.57	5.13	.50	4.63	.49	17.28	26.77
N. Y. 25028.	6.96	1.63	5.33	.49	15.88	26.70	5.64	.74	4.90	.56	16.87	27.08
N. Y. 25029.	5.83	.76	5.07	.73	16.21	26.54	5.59	.65	4.94	.65	16.59	26.48
N. Y. 25031.	7.45	2.25	5.20	.52	17.93	24.98	5.86	.85	5.01	.26	17.33	26.98
N. Y. 25190.	5.94	.93	5.01	.65	16.09	27.27	5.56	.77	4.79	.44	16.82	26.72
N. Y. 25195.	5.72	.65	5.07	.54	15.90	28.00	5.31	.50	4.81	.58	16.07	27.72
N. Y. 25245.	5.64	.86	4.78	.74	17.95	25.48	5.33	.66	4.67	.75	17.40	27.25
N. Y. 25348.	5.76	.73	5.03	.75	16.22	26.59	5.19	.54	4.65	.72	16.53	26.44
N. Y. 25399.	5.53	.73	4.80	1.09	17.14	26.73	5.38	.59	4.79	.74	17.83	25.87
N. Y. 25470.	7.07	1.95	5.12	1.59	16.52	26.30	5.75	.59	5.16	.63	17.41	26.80
N. Y. 25481.	6.21	1.19	5.02	1.72	15.91	26.16	5.66	.74	4.92	1.37	16.40	27.40
N. Y. 25566.	8.41	3.03	5.38	.73	16.00	25.21	5.55	.62	4.93	.76	17.01	26.12
N. Y. 25634.	5.35	.50	4.85	.28	16.89	26.12	4.86	.37	4.49	.25	16.81	25.39
I. S. 3817–C.	6.66	1.42	5.24	1.15	17.60	28.70	5.24	.55	4.69	.71	19.68	28.85
I. S. 3819–C.	5.77	.87	4.90	.97	18.76	27.93	5.58	.73	4.85	.40	18.38	28.16
I. S. 3820–C.	6.18	1.09	5.09	.91	16.99	27.97	5.38	.55	4.83	.66	18.13	28.00
I. S. 3822–C.	[1] 17.62	[1] 11.38	[1] 6.24	[1] .76	[1] 14.73	[1] 24.50	5.74	.72	5.02	.50	18.34	27.55
I. S. 3823–C.	7.31	2.26	5.05	.96	16.65	28.24	5.73	.73	5.00	.82	16.65	29.46
Average..	6.31	1.24	5.07	.81	17.26	26.86	5.51	.63	4.88	.64	17.52	27.23
Maximum	8.41	3.03	6.41	1.72	19.00	28.70	6.16	.85	5.44	1.37	19.68	29.46
Minimum	5.34	.44	4.73	.28	15.88	24.98	4.86	.37	4.49	.25	16.07	25.39
Japanese (Kobe) chillies or cayenne:												
N. Y. 24819.	5.08	.38	4.70	1.59	20.41	24.89	.....	.....	.....	.....	.....	.....
N. Y. 25004.	5.21	.58	4.63	.32	19.04	25.17	5.06	.38	4.68	.34	19.54	24.91
N. Y. 25010.	5.69	.53	5.16	.35	20.51	24.84	5.44	.49	4.95	.25	20.00	24.42
N. Y. 25011.	5.41	.77	4.64	.29	18.08	23.66	5.08	.48	4.60	.32	18.15	24.72
N. Y. 25012.	5.18	.66	4.52	.20	18.39	25.32	5.12	.51	4.61	.22	17.67	25.87
N. Y. 25013.	5.76	.73	5.03	.19	20.17	24.39	5.34	.46	4.88	.20	19.09	24.06
N. Y. 25014.	6.20	1.07	5.13	.28	20.26	24.11	5.70	.51	5.19	.25	20.57	25.05
N. Y. 25026.	5.86	.57	5.29	.88	23.21	24.18	5.79	.53	5.26	.97	22.89	24.65
N. Y. 25398.	5.26	.41	4.85	.24	20.77	22.83	5.10	.30	4.80	.10	20.14	22.86
N. Y. 25408.	5.55	.41	5.14	1.01	18.51	24.60	5.34	.32	5.02	.88	18.88	24.35
N. Y. 25409.	5.45	.31	5.14	.72	21.11	24.00	5.50	.27	5.23	.96	20.73	24.95
N. Y. 25410.	5.41	.33	5.08	.75	20.68	23.58	5.26	.33	4.93	.60	20.39	23.70
N. Y. 25567.	5.32	.57	4.75	.09	19.43	23.89	5.15	.37	4.78	.05	19.21	23.86
N. Y. 25678.	5.40	.36	5.04	.59	17.10	24.28	5.36	.39	4.97	.20	17.81	24.07
N. Y. 25679–A.....	5.52	.54	4.98	.27	20.14	22.82	5.40	.47	4.93	.20	19.10	24.44
N. Y. 25679–B.....	5.90	.40	5.50	.40	19.44	23.80	5.82	.47	5.35	.25	20.01	23.18
I. S. 3818–C.	5.71	.44	5.27	1.39	21.69	25.96	5.40	.37	5.03	1.14	21.20	26.08
Average..	5.52	.53	4.99	.56	19.94	24.25	5.37	.42	4.95	.43	19.71	24.45
Maximum	6.20	1.07	5.50	1.59	23.21	25.96	5.82	.53	5.35	1.14	22.89	26.08
Minimum	5.08	.31	4.52	.09	17.10	22.82	5.06	.27	4.60	.05	17.67	22.86
Cherry:												
N. Y. 25482.	6.62	1.23	5.39	1.18	16.17	26.20	5.82	.51	5.31	.77	17.56	25.77
Sweet red pepper:												
B. 4484.....	6.04	.40	5.64	.72	12.80	25.31	5.93	.42	5.51	.75	13.64	24.90
Siftings:												
I. S. 3821–C.	62.63	51.53	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

[1] Not included in average, maximum, and minimum.

The African or Mombasa chillies have the appearance of being dirty or sandy, and the analyses plainly show this condition. They are said to grow wild in the interior of tropical East Africa and are gathered by semicivilized people. They are dried on the ground and roofs of their huts or houses, thus subjected to the various conditions of the weather. They contain dirt, sand, stems, etc., and necessarily need cleaning before being ground for use. Attention is called to one sample, I. S. 3822–C, showing a most remarkable amount of sand and dirt present, which apparently could readily be sifted out, as the analysis of the sifted product shows a normal condition. The results on the sifted portions are remarkably uniform, showing only slight variations between the maximum and the minimum.

The Japanese or Kobe chillies differ in appearance, being very clean looking and of a much brighter color. The results plainly show this difference, as the amounts of sand and ash are materially lower. Many samples contained less than one-half per cent of sand, while in the Mombasa chillies practically none of the 50 samples ran as low as that.

I. S. 3822–C is so abnormal in its ash and ash insoluble in acid that none of the results are included in the average, maximum, and minimum results. Note how the sifting reduces the mineral matter and increases the nonvolatile ether extract and crude fiber, making them normal.

STANDARDS.

The standards given in Circular 19 of the Office of the Secretary for cayenne state that it shall contain not less than 15 per cent of nonvolatile ether extract, not more than 6.5 per cent of total ash, not more than 0.5 per cent of ash insoluble in hydrochloric acid, not more than 1.5 per cent of starch, and not more than 28 per cent of crude fiber.

As it is clear from the appearance and analysis of the African chillies that they must be cleaned or sifted before they are suitable for use, the results on only the sifted samples need be considered.

A study of the results on the sifted samples shows that the standard of 6.5 per cent total ash is sufficiently high, but nearly all of the Mombasa products exceeded the standard of 0.5 per cent sand, while a few (3 out of 16 samples) of the Kobe exceeded this limit.

The African chillies in a number of samples slightly exceeded the standard of 28 per cent for crude fiber. The crude fiber in the Kobe or Japanese chillies is considerably lower, averaging about 3 per cent less than in the African product.

DATA FROM LITERATURE.

A study of the literature was made and all the data that could be found by the authors on samples of cayenne of undoubted authenticity were collected. The following table was taken from the Connecticut Agricultural Experiment Station Annual Report for 1898 (p. 200), by Winton, Ogden, and Mitchell, and gives a summary of their results upon Japan, Zanzibar, and miscellaneous capsicums:

Results of analyses of cayenne pepper (Connecticut, 1898).

Variety.	Moisture.	Ash.		Ether extract.		Crude fiber.
		Total.	Insoluble in hydrochloric acid.	Volatile.	Nonvolatile.	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Japan (average 3)	5.95	5.65	0.09	0.99	21.28	21.68
Zanzibar (average 3)	5.13	5.43	.16	1.93	18.22	24.23
Capsicums (average 2)	6.28	5.11	.21	1.03	21.36	20.52
All analyses:						
Maximum	7.08	5.96	.23	2.57	21.81	24.91
Minimum	3.67	5.08	.05	.73	17.17	20.35
Average	5.73	5.43	.15	1.35	20.15	22.35

The samples were described as follows:

Japan cayenne or chillies: Entirely free from stems and calyxes. The pods are about 2 cm long and 0.5 cm wide at the widest part and of a most brilliant red color.

Zanzibar cayenne: This is one of the best varieties used for grinding, although at present the quality is rather poor. In the samples examined, the slender pods vary in length from 0.5 to 2.0 cm and are of a dull red or brown color. The stems and calyxes are present, but usually detached from the pods.

Capsicum or Bombay peppers: These are a low grade of chillies which are now said to come from the vicinity of the River Niger in Africa. In the samples examined, which are free from stems and calyxes, the brown or yellow pods are 2 to 3 cm long and nearly 1 cm broad.

The following table gives further results by the same authors, published in the Connecticut Agricultural Experiment Station Annual Report for 1899, page 102:

Results of analyses of cayenne pepper (Connecticut, 1899).

Variety.	Moisture.	Ash.		Ether extract.		Crude fiber.
		Total.	Insoluble in hydrochloric acid.	Volatile.	Nonvolatile.	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Chilli Colorado	15.96	6.19	0.04	0.36	15.45	13.93
Natal	13.58	5.51	.07	.85	16.00	19.12
Nepaul	5.71	6.07	.05	.85	20.46	24.25
Zanzibar	5.18	6.13	.15	.56	15.63	27.65

The samples were described as follows:

Chilli Colorado: A mild pepper grown in Mexico. The pods in the sample are of a dull brick color and from 7 to 10 cm long and (flattened) from 2 to 4 cm wide. The stems and calyxes are absent.

Natal or Durban cayenne pepper: The dark red pods (from 1 to 2 cm broad and 5 to 10 cm long) are free from stems and calyxes.

Nepaul cayenne pepper: A pepper grown in Hindustan with pods 3 to 6 cm long and 1 to 1.5 cm wide, of brown yellow color.

Zanzibar cayenne pepper: This sample is of fine quality, containing neither stems nor calyxes. The pods (0.5 to 1 cm long and from 0.3 to 0.5 cm wide) are brick red in color.

König [1] gives for cayenne pepper (average of 11 samples): Moisture 8.02 per cent; total ash, 5.61 per cent; insoluble ash, 0.12 per cent; volatile ether extract, 1.12 per cent; nonvolatile ether extract, 19.06 per cent; fiber, 21.98 per cent.

Sindall [2] gives for the total ash and ash insoluble in 10 per cent hydrochloric acid the following results:

Total ash and acid insoluble ash in cayenne pepper (Sindall).

	Ground in 1909.		Ground in 1910.		Ground in 1911.	
	Total ash.	Acid insoluble ash.	Total ash.	Acid insoluble ash.	Total ash.	Acid insoluble ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Average (20)[1]	6.15	0.84	6.78	0.67	(10) 6.00	0.58
Maximum (20)	7.14	1.08	8.43	.83	(10) 6.52	.70
Minimum (20)	5.44	.69	6.09	.52	(10) 5.64	.45

[1] The numbers in parentheses represent the number of samples examined.

Sindall's work represents samples of large lots of capsicum cleaned and ground in the factory under his personal supervision, arranged by years to show annual variations. The samples are composites taken at frequent intervals during grinding and each one represents as near as possible the composition of about 500 pounds of ground capsicum.

SUMMARY.

In Table 2 have been collected the results on cayenne peppers, giving the limit for ash, ash insoluble in acid, sand free ash, volatile ether extract, nonvolatile ether extract, and crude fiber, giving the maximum and minimum of the results obtained by this laboratory on the cleaned product, and also the maximum and minimum of the results taken from the literature. A study of the results obtained by the authors will show that the peppers seem to be quite uniform in composition, especially so when the sand is removed. The results

[1] Chemie der menschlichen Nahrungs-und Genussmittel, 1903, *1*: 953; 1904, *2*: 1037.
[2] J. Ind. Eng. Chem. 1911, *3*: 753.

taken from the literature, however, seem to show a much wider variation in the amount of crude fiber and in the amount of nonvolatile ether extract.

TABLE 2.—*Summary of results on cayenne peppers or chillies.*

Determination.	African chillies.		Japanese chillies.		Results from the literature.	
	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Total ash	4.86	6.16	5.06	5.82	5.08	8.43
Ash insoluble in acid	.37	.85	.27	.53	.04	1.08
Sand-free ash	4.49	5.44	4.60	5.35	.....	.....
Volatile ether extract	.25	1.37	.05	1.14	.36	2.57
Nonvolatile ether extract	16.07	19.68	17.67	22.89	15.45	21.81
Crude fiber	25.39	29.46	22.86	26.08	13.93	27.65

The results given by Sindall in the Journal of Industrial and Engineering Chemistry probably more nearly represent what can be produced on a factory scale under ordinary working conditions, and all of the results very clearly show that the standard for sand is low and not in accordance with the product now on the market. The older results given in the literature show a much lower sand content, probably due to the fact that they represent a product coming from a different source than the product now coming to this country.

PAPRIKA.

GENERAL DESCRIPTION.

Paprika is a large-fruited pepper, grown in Hungary, a variety of *Capsicum annuum* L., a species of *Capsicum*, which is a genus of the family Solanaceæ. When powdered, it has a deep red color and a sweetish, mildly pungent flavor. Its origin is somewhat obscure, but it apparently originated in America, whence it can be traced from Spain, through Greece and Turkey, to Hungary. It has been variously designated as Turkish pepper or paprika, Hungarian pepper or paprika, or garden pepper.

According to Csonka and Varadi,[1] there are five grades of Hungarian paprika known to commerce, as follows:

Rosenpaprika or Rózsapaprika.
Königspaprika or Királypaprika.
Merkantilpaprika.
Kranzpaprika.
Geschnittener Paprika.

The last two grades are practically unknown in the United States, as all of the paprika coming into the United States is ground.

[1] Der Szegeder Paprika und der Szegeder Paprikahandel, 1907.

Rosenpaprika, or Rózsapaprika, is the best grade of paprika made in Hungary, and has been known under this name since 1860, obtaining its name from its beautiful red color. It is produced with the utmost care from special, selected pods, the spotted and damaged parts being cut out, the placentæ, the stalks, and the stems removed, and the seeds and shells washed many times before being ground. The ground product has a bright red color and is distinguished by its pleasant taste. It will be noted that even in the highest grade of paprika the seeds are ground with the shells.

The second grade, or Königspaprika, is prepared by grinding the whole pod without selecting any of the pods, and includes not only the seeds, but also the stems, in the amount naturally occurring with the pod.

The Mercantile grade is produced from the spotted pods remaining from the selection for the finer grades and from the pods containing flaws, the lower grades of the Mercantile being ground with the stalks, stems, and other waste parts. This grade has, as a rule, a much more pungent taste and has a pale yellow color.

Szigeti [1] classes paprika in four grades, making a special grade above the Rózsapaprika, which he calls Ectes paprika; otherwise, he classifies them in practically the same manner as the previous authors. He calls attention to the fact that the Mercantile grade consists of scraps and waste from the other grades, and that the product is more pungent and has a yellow color, as distinguished from the higher grades.

ANALYSES.

The samples which were examined by the authors, the results of which are given in Table 4, were received under the seal of the Royal Hungarian Ministry of Agriculture through the Department of State. They consisted of large wreaths, were of a bright red color, sound, from 6 to 10 cm in length and from 2.5 to 4.0 cm in diameter, and of a conical shape.

In order to get at the composition of the different parts of the paprika, each sample was subdivided into five different portions, as follows: First, ground shells, stems, seeds, and placentæ; second, ground shells, seeds, and placentæ; third, ground shells alone; fourth, ground seeds and placentæ alone; fifth, ground stems alone. In the preparation of these products, they were ground separately and passed through a 0.5 mm sieve, with the exception of the seeds, which were passed through a 1 mm sieve.

[1] Zts. Landw. Versuchsw. Oesterr., 1902, *5*: 1208–22.

The results of this separation in percentage of shells, seeds, and placentæ, and stems are as follows:

TABLE 3.—*Separation of Hungarian paprikas for analysis.*

Serial No.	Shells.	Seeds and placentæ.	Stems.
	Per cent.	*Per cent.*	*Per cent.*
I. S. 8959–D	60.9	31.3	7.8
	60.7	31.2	8.1
	63.7	28.1	8.2
I. S. 8964–D	54.8	37.6	7.6
	55.2	37.1	7.7
	56.8	33.8	9.4
I. S. 8969–D	58.2	34.2	7.6
	56.6	36.2	7.2
	62.6	28.6	8.8
I. S. 8974–D	54.1	39.9	6.0
	54.4	39.5	6.1
	57.3	35.1	7.6
I. S. 8979–D	55.1	36.0	8.9
	53.9	38.6	7.5
	53.4	39.4	7.2
I. S. 8984–D	51.2	42.6	6.2
	50.5	43.2	6.3
	53.8	38.7	7.5
I. S. 8989–D	55.5	38.3	6.2
	55.6	38.4	6.0
	60.7	31.2	8.1
Average	56.4	36.1	7.5
Maximum	63.7	43.2	9.4
Minimum	50.5	28.1	6.0

The percentage was determined so that the effect of the addition of any of the parts in excess of the normal might be calculated, and thus a check had on the actual determinations made on the various grindings.

The percentage of these various parts is also of value in the microscopical examination of the ground product, in order to determine whether or not there is an abnormal percentage of seeds or stems present. It will be seen from this table that the percentage of stems never exceeds 10 per cent.

Sigmond and Vuk [1] made a similar separation on a large number of paprikas, and the following table is the average, maximum, and minimum of the results obtained by them. They separated the paprika, however, into four parts—pericarp or shells, seeds, placentæ, and stems—and their results show conditions very similar to those obtained by the authors.

Separation of paprikas (Sigmond and Vuk).

	Pericarp or shells.	Seeds.	Placentæ.	Stems.
Average	58.0	32.0	4.50	5.5
Maximum	60.0	40.0	5.25	5.8
Minimum	49.5	29.5	3.85	4.8

[1] Sigmond und Vuk. Beiträge zur chemischen Kenntnis des Paprika. Zts. Nahr. Genussm., 1911, 22:599.

Table 4 contains the results obtained by the authors on the various samples of Hungarian paprika, separated into their various parts and ground.

TABLE 4.—*Results on Hungarian paprikas separated into parts and ground.*

Serial No.	Volatile at 70° C. in vacuo.	Total ash.	Ash insoluble in 10 per cent hydrochloric acid.	Sand-free ash.	Total ether extract.	Nonvolatile ether extract.	Volatile ether extract.	Crude fiber.	Seeker's method.		Index of refraction at 40° C.
									Nonvolatile ether extract.	Iodin number.	
Shells, seeds and placentæ, and stems:	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		
I. S. 8959–D	3.76	5.96	0.33	5.63	12.87	12.21	0.66	21.77	10.86	134.0	1.4854
I. S. 8964–D	3.64	5.90	.30	5.60	14.19	13.27	.89	22.41	12.13	131.5	1.4804
I. S. 8969–D	3.29	5.68	.23	5.45	13.41	13.06	.35	22.76	11.48	133.4	1.4844
I. S. 8974–D	3.26	5.50	.24	5.26	15.43	15.11	.32	22.31	13.70	129.8	1.4823
I. S. 8979–D	3.34	6.03	.30	5.73	14.99	14.47	.52	21.29	12.85	133.0	1.4785
I. S. 8984–D	3.51	5.08	.26	4.82	16.56	16.43	.13	20.69	15.00	132.8	1.4758
I. S. 8989–D	3.49	5.29	.27	5.02	13.82	13.74	.08	22.30	12.23	133.8	1.4771
Average	3.47	5.63	.28	5.36	14.49	14.04	.42	21.93	12.61	132.6	1.4806
Maximum	3.76	6.03	.33	5.73	16.56	16.43	.89	22.76	15.00	134.0	1.4854
Minimum	3.29	5.08	.24	4.82	12.87	12.21	.08	20.69	10.86	129.8	1.4758
Shells, seeds and placentæ:											
I. S. 8960–D	3.43	5.30	.29	5.01	14.84	13.94	.90	21.10	12.64	132.6	1.4834
I. S. 8965–D	3.63	5.43	.26	5.17	14.86	14.60	.26	21.98	12.68	132.7	1.4820
I. S. 8970–D	3.17	5.16	.23	4.93	14.50	14.23	.27	23.18	12.96	129.5	1.4824
I. S. 8975–D	3.11	5.23	.20	5.03	16.75	16.23	.52	21.04	15.08	129.0	1.4813
I. S. 8980–D	3.35	5.56	.31	5.25	16.16	15.87	.29	21.45	14.11	133.2	1.4778
I. S. 8985–D	4.16	4.66	.25	4.41	17.43	17.35	.08	20.47	15.20	132.9	1.4756
I. S. 8990–D	3.75	5.18	.26	4.92	14.80	14.73	.07	21.67	12.71	133.2	1.4771
Average	3.51	5.22	.26	4.96	15.62	15.28	.34	21.56	13.91	131.9	1.4799
Maximum	4.16	5.56	.31	5.25	17.43	17.35	.90	23.18	15.08	133.2	1.4834
Minimum	3.11	4.66	.20	4.41	14.50	13.94	.07	20.47	12.64	129.0	1.4756
Shells:											
I. S. 8961–D	3.46	6.67	.31	6.36	5.38	5.14	.25	23.41	4.21	146.6	(1)
I. S. 8966–D	3.44	6.92	.37	6.55	5.74	5.46	.28	24.07	4.14	149.5	(1)
I. S. 8971–D	3.50	6.58	.27	6.31	6.73	6.38	.35	23.53	5.03	142.4	(1)
I. S. 8976–D	3.56	6.38	.25	6.13	7.19	6.90	.29	23.28	5.26	135.0	(1)
I. S. 8981–D	3.44	7.11	.27	6.84	6.98	6.54	.44	22.45	4.77	138.7	(1)
I. S. 8986–D	4.00	6.26	.22	6.04	6.28	6.12	.16	22.20	4.79	133.2	(1)
I. S. 8991–D	3.98	6.29	.25	6.04	6.11	5.93	.18	23.36	4.58	135.2	(1)
Average	3.63	6.60	.28	6.33	6.34	6.07	.28	23.19	4.68	140.1	(1)
Maximum	4.00	7.11	.37	6.84	7.19	6.90	.44	24.07	5.26	149.5	(1)
Minimum	3.44	6.29	.22	6.04	5.38	5.14	.16	22.20	4.14	133.2	.....
Seeds and placentæ:											
I. S. 8962–D	3.97	3.72	.30	3.42	26.84	26.84	.00	19.23	24.02	133.5	1.4697
I. S. 8968–D	4.02	3.49	.28	3.21	27.71	27.56	.15	19.90	24.96	133.6	1.4691
I. S. 8972–D	3.87	3.52	.23	3.29	26.80	26.74	.06	20.89	22.53	133.4	1.4697
I. S. 8977–D	3.80	3.77	.26	3.51	27.31	27.18	.13	21.41	23.03	133.6	1.4697
I. S. 8982–D	3.73	3.80	.21	3.59	27.57	27.52	.05	21.18	23.41	133.1	1.4694
I. S. 8987–D	4.23	3.38	.25	3.13	26.95	26.94	.01	21.08	24.20	134.0	1.4699
I. S. 8992–D	4.20	3.77	.26	3.51	25.99	25.97	.02	21.60	22.54	133.4	1.4694
Average	3.97	3.63	.26	3.38	27.02	26.96	.06	20.76	23.53	133.5	1.4696
Maximum	4.23	3.80	.30	3.59	27.71	27.56	.15	21.60	24.96	134.0	1.4699
Minimum	3.73	3.38	.21	3.13	25.99	25.97	.00	20.89	22.53	133.1	1.4691
Stems:											
I. S. 8963–D	5.38	10.73	.85	9.88	2.60	2.44	.16	29.34	.....	.....	.....
I. S. 8969–D	5.78	10.68	1.04	9.64	3.11	2.81	.30	30.50	.....	.....	.....
I. S. 8973–D	4.66	10.52	.77	9.75	2.99	2.73	.26	31.02	.....	.....	.....
I. S. 8978–D	5.00	10.00	.75	9.25	3.40	3.05	.35	30.58	.....	.....	.....
I. S. 8983–D	5.34	11.35	.68	10.67	2.56	2.36	.20	30.72	.....	.....	.....
I. S. 8988–D	5.18	11.00	1.20	9.80	2.47	2.30	.17	30.46	.....	.....	.....
I. S. 8993–D	5.23	9.84	.66	9.18	2.25	2.10	.15	32.06	.....	.....	.....
Average	5.22	10.59	.85	9.74	2.77	2.54	.23	30.67	.....	.....	.....
Maximum	5.78	11.35	1.20	10.67	3.40	3.05	.35	32.86	.....	.....	.....
Minimum	4.66	9.84	.66	9.18	2.25	2.11	.15	29.34	.....	.....	.....

[1] Not read.

The first set, where the shells, seeds and placentæ, and stems were ground together, represents the grade mentioned before as the Kings or Königs grade, and in all probability represents, as a rule,

the grade received in this country. The second set, where the shells, seeds, and placentæ were ground together, would represent the better grade, Rózsapaprika, or Rosenpaprika. It will be seen from a study of these two sets of figures that the grinding of a normal amount of stems has comparatively little effect upon the chemical composition of the paprika, the grinding of the stems slightly increasing the total amount of ash, and slightly reducing the amount of total ether extract, and also slightly increasing the crude fiber, but not affecting any of these ingredients to such an extent as to throw them beyond the normal variation found in the various samples. In the next set of figures, where the shells were ground alone, a product was obtained which is not a commercial product. It will be seen that the ash of the shells and the crude fiber of the shells is somewhat higher and the amount of oil is much lower, the composition of the latter being somewhat different, having an appreciably higher iodin number.

The results obtained on the seeds and placentæ ground alone are very different from the results found on the shells alone. The ash of the former is very much lower and the ether extract very much higher; in fact, most of the oily material is present in the seeds. The volatile ether extract, however, in the seeds appears to be practically negligible. The stems, when ground alone, show a very much higher ash and sand content and a very much higher amount of crude fiber. The ether extract is very low.

The effect of the addition of stems to a ground paprika would be to increase the ash and sand, decrease the amount of ether extract, and increase the amount of fiber. The effect of the addition of excessive amounts of seeds would be to lower the ash, to increase the amount of ether extract, and to affect the other constitutents only slightly. Excess of seeds is not often found in paprika, but the possibility of added stems being ground is much greater, for the reason that in the preparation of the finest grades of paprika, the stems are removed, and undoubtedly in the preparation of such grades as the Mercantile, there might be an excess of stems.

The grinding of seeds normal to the pods in preparing paprika seems to be a well recognized custom founded upon experience that a better grade is thus produced. This is undoubtedly due to the high fat content of the seeds, which intensifies the color and develops or brings out the flavor to a better advantage. When the normal amount of stems is ground, the effect is to produce a product of a little lighter shade of red, but one that does not materially differ in odor and taste from the product which is ground simply from the pod.

In order to get some idea of the taste and flavor of the various parts of the paprika, pods from different samples were broken up into

the following parts: Stems, seeds, shells, and central and wall placentæ, and each of these parts was found to have a distinct taste and flavor. The stems are gray in color and have very little taste. The seeds are of a lemon-yellowish color and have a peculiar, sweetish, bland taste, with little, if any, pungency. The shells, or pericarps, have a peculiar, sweetish, slightly acid taste, more pronounced than the seeds, and with a little pungency. They, however, contain practically all of the deep red color. The central placenta has a sweetish, slightly acid, slippery taste with some pungency, and a slight pinkish color. The wall placentæ, however, are the source of the pungency in paprika, containing practically all of the capsaicin; they have a deep red color.

In the ground samples, the results of analysis of which are given in Table 4, the shells alone have a pleasant, sweetish, slightly acid taste, with some pungency, a distinct and pronounced, though not strong, odor peculiar to paprika and a light brick-red color. The seeds and placentæ have a sweetish, bland, slightly pungent taste, with little odor, and are orange yellow in color. The stems are slightly pungent, due to the particles of placentæ attached, have a slight paprika odor, due to the same condition, and a gray color. When, however, the shells, seeds, and placentæ are ground together in their normal proportion, the sample has a bright, brick-red color, and a much stronger paprika odor, but less distinctive taste, than when the shells are ground alone.

STANDARDS.

The standard for paprika given in Circular 19, Office of the Secretary, is as follows:

"Paprika is the dried ripe fruit of *Capsicum annuum* L., or some other large-fruited species of *Capsicum*, excluding seeds and stems." It would appear from our results that this is not a correct definition of the best commercial product, which includes the seeds normal to the pod.

The standard [1] of Austria-Hungary does not allow an excess of 8 per cent of total ash and 1 per cent of ash insoluble in hydrochloric acid. The German standard [2] holds that paprika should not contain more than 6.5 per cent of ash, and not more than 1 per cent of ash insoluble in hydrochloric acid. The Swiss standard [3] requires that there shall not be more than 5 per cent of ash, and not more than 0.5 per cent of ash insoluble in hydrochloric acid.

[1] Codex Alimentarius Austriacus.
[2] Deutsches Nahrungsmittelbuch, 2. aufl.
[3] Schweizer Lebensmittelbuch.

DATA FROM LITERATURE.

The following table gives a summary of the results obtained by Doolittle and Ogden, published in the Journal of the American Chemical Society for 1908, volume 30, page 1481:

Data on Hungarian paprika (Doolittle and Ogden).[1]

Portion analyzed.	Loss at temperature of boiling water.	Total ash.	Ash insoluble in 10 per cent hydrochloric acid.	Total ether extract.	Volatile ether extract.	Nonvolatile ether extract.	Crude fiber.	Iodin number of ether extract.
Whole pods (6 samples):	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
Average	8.54	6.28	0.10	10.15	0.85	9.30	18.36	133.0
Maximum	9.39	7.06	.22	12.56	1.25	11.99	19.83	136.8
Minimum	7.26	5.63	.05	8.67	.17	7.42	15.10	130.3
Shells (7 samples):								
Average	10.37	6.03	.05	5.89	.80	5.08	19.50	133.1
Maximum	10.86	6.90	.08	7.62	1.10	6.69	23.61	138.0
Minimum	9.45	5.50	.03	4.86	.44	4.01	16.66	127.7
Seeds and placentæ (7 samples):								
Average	5.80	3.90	.07	21.79	1.50	20.31	18.74	133.3
Maximum	6.46	4.93	.09	23.60	1.90	22.34	20.11	135.4
Minimum	5.00	3.06	.05	19.39	.95	17.66	17.29	130.2
Stems (7 samples):								
Average	6.55	11.32	.44	2.36	.48	1.94	24.47	.....
Maximum	9.58	12.25	.61	3.10	.78	2.39	29.94	.....
Minimum	3.10	10.03	.30	1.65	.27	1.38	19.86	.....

[1] J. Amer. Chem. Soc., 1908, *30:* 1481.

Bitto [1] gives the following results on samples of authentic history:

Results on samples of paprika to dry basis (Bitto).

Portion analyzed.	Ash.	Ether extract.	Crude fiber.
	Per cent.	*Per cent.*	*Per cent.*
Whole fruit without stems	6.76	10.69	22.95
Shells	5.66	5.14	25.83
Seeds	4.35	27.95	17.36
Placentæ	11.03	7.07	13.48

Strohmer [2] gives the following results upon the whole fruit, shells, and the seed:

Results on samples of paprika to dry basis (Strohmer).

Portion analyzed.	Ash.	Ether extract.	Crude fiber.
	Per cent.	*Per cent.*	*Per cent.*
Whole fruit	5.90	17.29	23.94
Shells	7.76	6.42	27.83
Seeds	3.48	31.06	19.04

[1] Über die chemische Zusammensetzung der reifen Paprika-schote. Landw. Versuchs-Stat., 1893, *42*: 369.

[2] Strohmer. Die chemische Zusammensetzung und Prüfung des Paprikas. Chem. Centrbl., 1884, p. 557.

Winton, Ogden, and Mitchell[1] give the results on 1 sample of paprika as follows:

Results on 1 sample of paprika (Winton, Ogden, and Mitchell).

	Per cent.
Moisture	8.77
Total ash	6.45
Water soluble ash	5.05
Ash insoluble in hydrochloric acid	.11
Volatile ether extract	1.12
Nonvolatile ether extract	7.74
Crude fiber	22.59

This sample was prepared from dried pods, which were from 7 to 10 cm long, flattened, from 3 to 7 cm wide, and of a deep red color.

SUMMARY.

In the following table have been collected the maximum and minimum figures from the literature, and the results from the samples examined by the authors. A much wider variation is found in the former.

TABLE 5.—*Maximum and minimum results on paprika.*

DATA OBTAINED BY AUTHORS.

Determination.	Shells, seeds, placentæ, and stems.		Shells, seeds, and placentæ.		Seeds and placentæ.		Shells.		Stems.	
	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.
Loss at 70° C. in vacuo (per cent)	3.29	3.76	3.11	4.16	3.73	4.23	3.44	4.00	4.66	5.78
Total ash (per cent)	5.08	6.03	4.66	5.56	3.38	3.80	6.29	7.11	9.84	11.35
Ash insoluble in 10 per cent hydrochloric acid (per cent)	.24	.33	.20	.31	.21	.30	.22	.37	.66	1.20
Sand-free ash (per cent)	4.82	5.73	4.41	5.25	3.13	3.59	6.04	6.84	9.18	10.67
Total ether extract (per cent)	12.87	16.56	14.50	17.43	25.99	27.71	5.38	7.19	2.25	3.40
Nonvolatile ether extract (per cent)	12.21	16.43	13.94	17.35	25.97	27.56	5.14	6.90	2.11	3.05
Volatile ether extract (per cent)	.08	.89	.07	.90	.00	.15	.16	.44	.15	.35
Crude fiber (per cent)	20.69	22.76	20.47	23.18	20.89	21.60	22.20	24.07	29.34	32.86
Seeker's method: Iodin number	129.8	134.0	129.0	133.2	133.1	134.0	133.2	149.5	.....	.....
Nonvolatile ether extract (per cent)	10.86	15.00	12.64	15.08	22.53	24.96	4.14	5.26	.....	.....
Index of refraction at 40° C.	1.4758	1.4854	1.4756	1.4834	1.4691	1.4699	.....	.....	.....	.....

DATA FROM LITERATURE.

Determination.	Shells, seeds, placentæ, and stems.		Shells, seeds, and placentæ.	Seeds and placentæ.		Shells.		Stems.		Seeds.		Placentæ.
	Minimum.	Maximum.		Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	
Loss at 100° C (per cent)	7.26	9.39	.....	5.00	6.46	9.45	10.86	3.10	9.58	.....	.....	.....
Total ash (per cent)	5.63	7.06	6.76	3.06	4.93	5.50	7.76	10.03	12.25	3.48	4.35	11.03
Ash insoluble in 10 per cent hydrochloric acid (per cent)	.05	.22	.....	.05	.09	.03	.08	.30	.61	.....	.....	.....
Total ether extract (per cent)	8.67	12.56	.....	19.36	23.60	4.86	7.62	1.65	3.10	.....	.....	.....
Nonvolatile ether extract (per cent)	7.42	17.29	10.69	17.66	22.34	4.01	6.69	1.38	2.39	27.95	31.06	7.07
Volatile ether extract (per cent)	.17	1.25	.....	.95	1.90	.44	1.10	.27	.78	.....	.....	.....
Crude fiber	15.10	23.94	22.95	17.29	20.11	16.66	27.83	19.86	29.94	17.36	19.04	13.48
Seeker's method: Iodin number	130.3	136.8	.....	130.2	135.4	127.7	138.0	.....	.....	.....	.....	.....

[1] Conn. Agr. Exper. Sta., Ann. Rept., 1899, p. 102.

PIMENTON, OR PIMIENTO.[1]

GENERAL DESCRIPTION.

The pimenton, or pimiento, is a large-fruited pepper, a variety of *Capsicum annuum* L., grown in Spain, and, under the standard given in Circular 19, Office of the Secretary, would be classified, when ground, as paprika. The succulent pericarp of this pepper is much used for stuffing of olives, while the dried pod is ground as a spice. A large quantity of this pepper imported to the United States is used largely on account of its high coloring properties. The taste and flavor is quite different from the Hungarian paprika.

The samples which were examined during this study were received under seal from the American consul general at Barcelona, Spain, and consisted of large wreaths, the pods of which were of a bright red color, sound, and from 2.5 to 4 cm in length, and from 4 cm to 6 cm in diameter, having a nearly round shape.

ANALYSES.

Five different grindings were made from each set of peppers. In the first case, the shells, seeds and placentæ, and stems were ground together; in the second, the shells, seeds and placentæ; in the third, the shells alone; in the fourth, the shells and placentæ; in the fifth, the stems alone. Table 6 gives the percentage composition of the various parts of the pods used in the above ground samples.

TABLE 6.—*Composition of Spanish pimenton.*

Serial No.	Shells.	Seeds and placentæ.	Stems.
	Per cent.	*Per cent.*	*Per cent.*
I. S. 8907–D	54.1	36.2	9.7
I. S. 8910–D	53.1	36.0	10.9
I. S. 8913–D	57.0	34.9	8.1
I. S. 8994–D	53.7	36.9	9.4
	55.7	35.7	8.6
	54.1	37.4	8.5
I. S. 18974–D	55.6	35.5	8.9
	54.6	37.0	8.4
	58.1	35.9	6.0
I. S. 18979–D	57.1	34.1	8.8
	55.7	36.8	7.5
	55.1	36.6	8.3
I. S. 18984–D	54.2	36.6	9.2
	56.3	35.3	8.4
	54.8	36.1	9.1
I. S. 18989–D	54.1	36.2	9.7
	54.8	35.6	9.6
	56.0	35.7	8.3
Average	55.3	36.0	8.7
Maximum	58.1	37.4	10.9
Minimum	53.1	34.9	6.0

The percentage was determined so that the effect of an addition of any of the parts in excess of the normal might be calculated and

[1] "Pimenton" should not be confused with "pimento" or "pimenta," which is applied to Jamaica pepper or allspice, "Pimenton" is the definite term used to designate the Spanish product, when ground.

thus a check had on the actual determinations made on the various grindings. The percentage of these parts is also of value in the microscopical examination of the ground product in order to determine whether or not there is an abnormal percentage of any of the parts.

Table 7 gives the analytical results on the various ground samples:

TABLE 7.—*Analytical results on ground Spanish pimenton, or pimiento.*

Serial No.	Volatile at 70° C. in vacuo.	Total ash.	Ash insoluble in 10 per cent hydrochloric acid.	Sand-free ash.	Total ether extract.	Nonvolatile ether extract.	Volatile ether extract.	Crude fiber.	Seeker's method.		Index of refraction at 40° C.
									Nonvolatile ether extract.	Iodin number.	
Shells, seeds and placentæ, and stems:	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*		
I. S. 8901-D	.....	7.86	0.32	7.54	11.99	11.30	0.69	20.02	.....	.....	.....
I. S. 8903-D	.....	7.66	.48	7.18	11.93	11.37	.56	20.13	.....	.....	.....
I. S. 8905-D	.....	7.34	.33	7.01	12.57	11.91	.66	20.13	.....	.....	.....
I. S. 8994-D	4.68	7.21	.30	6.91	12.68	12.58	.10	20.33	10.81	136.0	1.4776
I. S. 18974-D	5.28	6.98	.29	6.69	12.03	11.72	.31	20.18	10.36	137.3	1.4818
I. S. 18979-D	5.98	7.40	.44	6.96	12.11	11.64	.47	19.53	9.81	136.3	1.4808
I. S. 18984-D	4.31	7.31	.29	7.02	13.06	12.58	.48	20.59	10.36	137.2	1.4818
Average	5.06	7.39	.35	7.04	12.34	11.87	.47	20.13	10.34	136.7	1.4805
Maximum	5.98	7.86	.48	7.54	13.06	12.58	.69	20.59	10.81	137.3	1.4818
Minimum	4.31	6.98	.29	6.69	11.93	11.30	.10	19.53	9.81	136.0	1.4776
Shells, seeds and placentæ:											
I. S. 8902-D	.....	7.29	.32	6.97	13.09	12.58	.51	19.17	.....	.....	.....
I. S. 8904-D	.....	7.14	.40	6.74	12.45	11.85	.60	19.97	.....	.....	.....
I. S. 8906-D	.....	6.97	.32	6.65	13.27	12.75	.52	19.44	.....	.....	.....
I. S. 8995-D	4.92	6.68	.28	6.40	12.67	12.37	.30	19.59	10.74	137.0	1.4793
I. S. 18975-D	5.09	6.60	.34	6.26	12.48	12.12	.36	20.34	10.53	137.2	1.4809
I. S. 18980-D	4.89	6.79	.24	6.55	13.64	13.15	.49	19.10	11.30	134.5	1.4792
I. S. 18985-D	4.74	6.98	.29	6.69	13.85	13.34	.51	18.76	10.98	136.0	1.4810
I. S. 18990-D	4.52	7.35	.37	6.98	11.83	11.58	.25	19.57	9.80	135.6	1.4802
Average	4.83	6.98	.32	6.66	12.91	12.47	.44	19.49	10.67	136.1	1.4801
Maximum	5.09	7.35	.40	6.98	13.85	13.34	.60	20.34	11.30	137.2	1.4810
Minimum	4.52	6.60	.24	6.26	11.83	11.58	.25	18.76	9.80	134.5	1.4792
Shells:											
I. S. 8907-D	.....	8.02	.29	7.73	7.52	6.47	1.05	18.34	.....	.....	.....
I. S. 8910-D	.....	7.77	.33	7.44	7.34	6.48	.86	17.78	.....	.....	.....
I. S. 8913-D	.....	8.39	.33	8.02	7.04	6.12	.92	18.67	.....	.....	.....
I. S. 8996-D	4.88	8.46	.37	8.09	5.85	5.44	.41	18.70	4.46	142.4	1.4958
I. S. 18976-D	4.76	7.55	.26	7.29	7.45	6.81	.64	17.26	4.67	142.4	1.4964
I. S. 18981-D	5.02	7.79	.27	7.52	7.17	6.36	.81	17.95	4.34	136.7	1.4961
I. S. 18986-D	4.77	8.07	.30	7.77	6.77	6.24	.53	17.29	4.26	143.7	1.4963
I. S. 18991-D	4.74	7.83	.37	7.46	6.98	6.51	.47	18.34	4.55	139.7	1.4968
Average	4.83	7.99	.32	7.67	7.02	6.30	.71	18.04	4.46	141.0	1.4963
Maximum	5.02	8.46	.37	8.09	7.52	6.81	1.05	18.70	4.67	143.7	1.4968
Minimum	4.74	7.55	.26	7.29	5.85	5.44	.41	17.26	4.26	136.7	1.4958
Seeds and placentæ:											
I. S. 8908-D	.....	4.43	.31	4.12	24.89	24.58	.31	20.90	.....	.....	.....
I. S. 8911-D	.....	4.66	.26	4.40	24.60	24.23	.37	19.90	.....	.....	.....
I. S. 8914-D	.....	4.68	.29	4.39	23.86	23.58	.28	21.76	.....	.....	.....
I. S. 8997-D	4.12	4.94	.30	4.64	22.24	21.82	.42	24.08	19.88	130.3	1.4695
I. S. 18977-D	3.95	4.71	.24	4.47	22.99	22.87	.12	22.93	20.26	130.8	1.4698
I. S. 18982-D	4.00	5.02	.28	4.76	22.33	22.26	.07	23.13	19.37	130.0	1.4700
I. S. 18987-D	3.59	4.95	.22	4.73	23.46	23.39	.07	22.22	21.35	128.1	1.4702
I. S. 18992-D	3.93	4.90	.29	4.61	22.15	22.10	.05	24.04	19.11	130.1	1.4700
Average	3.92	4.79	.27	4.52	23.32	23.10	.21	22.37	19.99	129.9	1.4699
Maximum	4.12	5.02	.31	4.76	24.89	24.58	.42	24.08	21.35	130.8	1.4702
Minimum	3.59	4.43	.22	4.12	22.15	21.82	.05	19.90	19.11	128.1	1.4695
Stems:											
I. S. 8909-D	.....	13.06	.70	12.36	2.12	1.63	.49	30.98	.....	.....	.....
I. S. 8912-D	.....	13.78	.64	13.14	2.45	2.05	.40	27.66	.....	.....	.....
I. S. 8915-D	.....	13.00	.58	12.42	1.67	1.22	.45	.....	.....	.....	.....
I. S. 8998-D	5.94	15.63	.72	14.91	1.52	1.24	.28	28.57	.....	.....	.....
I. S. 18978-D	4.86	14.67	.74	13.93	1.65	1.35	.30	30.76	.....	.....	.....
I. S. 18983-D	5.94	15.77	1.07	14.70	1.55	1.30	.25	28.59	.....	.....	.....
I. S. 18988-D	4.89	15.34	.67	14.67	1.61	1.42	.19	29.96	.....	.....	.....
I. S. 18993-D	5.14	14.98	.67	14.31	1.48	1.33	.15	29.50	.....	.....	.....
Average	5.35	14.53	.73	13.81	1.76	1.44	.31	29.43	.....	.....	.....
Maximum	5.98	15.77	1.07	14.91	2.45	2.05	.49	30.98	.....	.....	.....
Minimum	4.86	13.00	.58	12.36	1.48	1.22	.15	27.66	.....	.....	.....

The first set of analyses gives the results on the ground powder made from the whole pod, including the stem, and represents a grade corresponding to the Königspaprika of Hungary. The second lot of samples examined consisted of the shells, seeds, and placentæ ground together, which correspond to the Rosenpaprika, or Rózsapaprika of Hungary, or the highest grade. A study of these two sets of analyses will not show any great differences. The presence of the stems slightly increases the ash, slightly decreases the total amount of ether extract and slightly increases the amount of crude fiber.

A comparison of the results obtained on the ground shells alone, however, shows that there is a considerable difference between this grade and the two above, the ash being higher, the ether extract very much lower, and apparently of a slightly different composition, as is shown by the higher iodin number obtained on it. The seeds and placentæ show very much the same differences noted with the Hungarian paprika, being lower in ash, higher in fat, and somewhat higher in crude fiber.

The analysis of the ground stems shows that they are very much higher in ash and sand than the other parts of the plant, but very much lower in ether extract.

The effect of an excess of stems in pimenton would be to increase the ash, to lower the ether extract, to increase the amount of sand, and to increase the amount of crude fiber; while the addition of an excess of ground seeds and placentæ would be to reduce the amount of ash, to increase the amount of fat, and to affect the other constituents only slightly. Undoubtedly the chief possibility of adulteration of these products would be in adding an excess of stems, using those stems separated in the preparation of the higher grades of products.

In order to study the taste and odor of these products, and especially the taste and odor of the various parts, pods from different samples were broken up in the same manner as was done with the paprika. It was found that the stems have very little taste or flavor, and are gray in color when ground. The seeds have a very slight bitter, bland taste, with a little odor, and the ground product is orange yellow in color. The pericarps or shells have a peculiar slightly sweet, acid taste, but have the distinct and pronounced flavor characteristic of the pimenton, quite different from that of the paprika, and have a beautiful deep-red color. The central placenta has a slightly acid, bland taste and a pinkish color, while the wall placentæ have a taste similar to the shells, but not so pronounced, and are dark red in color. None have any perceptible amounts of pungency, in which they differ very materially from the Hungarian paprika.

When the shells, seeds, and placentæ are ground together in their normal proportions, the sample has a little better color, and a little stronger pimenton odor, than when the shells are ground alone; the oily material in the seeds seems to bring out not only the color but also the flavor of the ground product. The effect of grinding the stems on the finished product was not particularly marked, either in taste, appearance, or in chemical composition. The results, however, show that the Spanish product runs materially higher in ash than the Hungarian product, which is undoubtedly due to some difference in climatic conditions or in the soil, as it does not appear to be a difference in sand alone, but in actual composition of the pimenton itself.

STANDARDS.

No figures are given in the standards of Circular 19 for either paprika or pimenton. The Spanish Government has promulgated a standard in which they give the maximum ash not to exceed 10 per cent, ether extract not to exceed 18 per cent, the moisture not to exceed 12 per cent.

DATA FROM LITERATURE.

The following tables give the results obtained by Doolittle and Ogden, published in the Journal of the American Chemical Society, 1908, volume 30, page 1481, and those obtained by Lowenstein and Dunne, published in the Journal of Industrial and Engineering Chemistry, 1910, volume 2, page 139:

Analytical results on Spanish pimenton (Doolittle and Ogden).[1]

Portion analyzed.	Loss at temperature of boiling water.	Total ash.	Ash insoluble in 10 per cent hydrochloric acid.	Total ether extract.	Volatile ether extract.	Nonvolatile ether extract.	Crude fiber.	Iodin number of ether extract.
Whole pods (2 samples):	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	
Average	8.43	6.02	0.05	12.00	1.18	10.39	15.37	135.3
Maximum	8.58	6.79	.06	12.44	.....	.....	.....	136.1
Minimum	8.28	5.24	.05	11.57	.....	.....	.....	134.5
Shells (3 samples):								
Average	7.69	7.17	.11	5.40	.95	4.62	15.00	131.0
Maximum	10.35	7.68	.20	5.88	1.40	4.76	15.19	133.0
Minimum	6.26	6.23	.05	5.06	.51	4.48	14.80	130.0
Seeds and placentæ (3 samples):								
Average	5.74	4.41	.06	22.63	1.91	19.40	21.74	132.1
Maximum	6.58	5.20	.11	25.28	2.25	19.80	24.01	133.3
Minimum	5.19	3.41	.04	20.55	1.56	18.99	19.48	130.7
Stems (2 samples):								
	3.44	.....	.....	1.27	.29	.98	.....	.....
	6.03	15.50	.26	.....	.....	.....	29.99	.....

[1] Doolittle and Ogden, J. Amer. Chem. Soc. 1908, 30: 1481.

Analytical results on Spanish pimenton (Lowenstein & Dunne).[1]

Portion analyzed.	Loss at 105° C. after deducting volatile.	Total ash.	Ash insoluble in 10 per cent hydrochloric acid.	Total ether extract.	Volatile ether extract.	Nonvolatile ether extract.	Crude fiber.	Iodin number.
Shells (4 samples):	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	
Average	11.36	9.38	0.19	6.35	0.59	5.75	20.61	133.8
Maximum	15.90	10.00	.31	6.80	.75	6.55	24.60	136.5
Minimum	5.87	8.77	.10	5.82	.25	5.12	18.70	130.2
Seeds (3 samples):								
Average	5.98	3.49	.13	21.12	.46	20.66	28.28	112.0
Maximum	6.63	3.84	.20	22.03	.60	21.51	29.45	113.9
Minimum	5.48	3.22	.04	20.36	.27	20.09	27.39	110.1
Stems	3.66	.....	.....	3.24	.30	2.94	31.26	.....

[1] Lowenstein & Dunne, J. Ind. Eng. Chem. 1910, *2*: 139.

SUMMARY.

Table 8 gives the maximum and minimum of the results obtained in the work of the authors and of the results found in the literature.

The only points of special difference in these results are the low iodin absorption figures found by Lowenstein and Dunne on the oil from the seeds of their samples, which appear to be very abnormal, being entirely different from any of the results obtained by Doolittle and Ogden or by the authors.

TABLE 8.—*Summary of analytical results on Spanish pimenton.*

DATA OBTAINED BY AUTHORS.

Determinations.	Shells, seeds, placentæ, and stems.		Shells, seeds, and placentæ.		Shells.		Seeds and placentæ.		Stems.	
	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.
Loss at 70° C. in vacuo (per cent)	4.31	5.98	4.52	5.09	4.74	5.02	3.59	4.12	4.86	5.98
Total ash (per cent)	6.98	7.86	6.60	7.35	7.55	8.46	4.43	5.02	13.00	15.77
Ash insoluble in 10 per cent hydrochloric acid (per cent)	.29	.48	.24	.40	.26	.37	.22	.31	.58	1.07
Sand-free ash (per cent)	6.69	7.54	6.26	6.98	7.29	8.09	4.12	4.76	12.36	14.91
Total ether extract (per cent)	11.93	13.06	11.83	13.85	5.85	7.52	22.15	24.89	1.48	2.45
Nonvolatile ether extract (per cent)	11.30	12.58	11.58	13.34	5.44	6.81	21.82	24.58	1.22	2.05
Volatile ether extract (per cent)	.10	.69	.25	.60	.41	1.05	.05	.42	.15	.49
Crude fiber (per cent)	19.53	20.59	18.76	20.34	17.26	18.70	19.90	24.08	27.66	30.98
Seeker's method:										
Iodin number	136.0	137.3	134.5	137.2	136.7	143.7	128.1	130.8	.....	.....
Ether extract (per cent)	9.81	10.81	9.80	11.30	4.26	4.67	19.11	21.35	.....	.....
Index of refraction at 40° C.	1.4776	1.4818	1.4792	1.4810	1.4958	1.4968	1.4695	1.4702	.....	.....

TABLE 8.—*Summary of analytical results on Spanish pimenton*—Continued.

DATA FROM LITERATURE.

Determinations.	Whole pods (shells, seeds, placentæ, stems).		Shells.		Stems.		Seeds and placentæ.		Seeds.	
	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.
Loss at 100° C (per cent)	8.28	8.58	6.26	10.35	3.44	6.03	5.19	6.58	.....	.....
Total ash (per cent)	5.24	6.79	6.23	10.00	15.50	.....	3.41	5.20	3.22	3.84
Ash insoluble in 10 per cent hydrochloric acid (per cent)	.05	.06	.05	.31	.26	.....	.04	.11	.04	.20
Total ether extract (per cent)	11.57	12.44	5.06	6.80	1.27	3.24	20.55	25.28	20.36	22.03
Nonvolatile ether extract (per cent)	.....	.....	4.48	6.55	.98	2.94	18.99	19.80	20.09	21.51
Volatile ether extract (per cent)	.....	.....	.25	1.40	.29	.30	1.56	2.25	.27	.60
Crude fiber (per cent)	15.37	.....	14.80	24.60	29.99	31.26	19.48	24.01	27.39	29.45
Loss at 105° C. after deducting volatile ether extract (per cent)	.....	.....	5.87	15.90	3.66	.....	.....	.....	5.48	6.63
Seeker's method—Iodin number	134.5	136.1	130.0	136.5	.....	.....	130.7	133.3	110.1	113.9

CONCLUSIONS.

CAYENNE.

The first point of special interest to be noted is the fact that the Mombasa, or African, chillies now coming into this country are exceedingly dirty, and must necessarily be very carefully cleaned before they are ground. This condition is undoubtedly brought about by the fact that they grow wild in the interior of Africa, and are gathered by semi-savage tribes and dried under various conditions.

The results given in the tables further show that the product now coming into this country is somewhat different from that which was formerly shipped; this is especially shown by a comparison of the results obtained by the authors with those obtained by Winton and his collaborators a number of years ago. There does not, however, seem to be any difficulty in producing a sound product of a satisfactory nature by carefully sifting out the dirt and sand.

It is also likely that the conditions which control the production of this product may vary in the course of a number of years, so that the cayenne on the market may vary from time to time as the source of the chillies varies.

At the present time a considerable amount of small, round-shaped chillies, known as "cherries," grown in India, is being brought into this country, and practically none of the true Zanzibar chillies is being received, although some chillies are still shipped from Zanzibar which are undoubtedly the same as those coming from Mombasa, and their source is the interior of Africa and not the island of Zanzibar.

The sand present in these products appears to be entirely of an extraneous nature, and they can be sifted so that an entirely uniform product is obtained. An examination of the tables shows that the sand-free ash of these products, regardless of source, is extremely uniform, and as a criterion of the product it would appear that this figure would be of great value.

The Kobe, or Japanese, chillies are comparatively clean and need but little sifting to produce a satisfactory product. These, however, are used in the preparation of "chilli sauce," and not for grinding purposes.

A careful study of the various tables shows that in judging the various varieties of cayenne—African, Japanese, and Indian—they should be compared with data obtained upon chillies from the same source.

HUNGARIAN PAPRIKA.

From the study of the literature and the information available in the course of this investigation, it would appear that the word "paprika" has generally referred in the past to a product made in Hungary, but now it is applied to similar products produced in Spain and America; it is clear that the word "Rosenpaprika," or "Rózsapaprika," is limited to a well-defined product which has been made in Hungary for a long period of time and consists of the highest grade of pods ground without the stems.

Further, it is clear that the grinding of the stems with a product of this kind is simply for the purpose of producing more weight and acting as a filler, and that it does not add any valuable qualities to the product, as it contains no flavoring principles. It is also clear that the grinding of the seeds and placentæ with the pods produces an improved product, and all of the facts seem to indicate that it is a well recognized and legitimate process.

The results show that paprika must be judged from data obtained upon samples of paprika from a known source.

PIMENTON, OR SPANISH PAPRIKA.

It appears from this investigation that this product is commonly known as "Spanish paprika," or "pimenton." It is quite different in its flavoring qualities and value from Hungarian paprika, and should be properly distinguished from it. It has very little pungency and its flavor is different from that of the Hungarian product.

Further, the analytical results upon the pimenton show that the different conditions under which it is grown have affected, to a greater or less extent, the amount of ash and other ingredients present, clearly showing that in the judging of these products it is necessary to compare the Hungarian paprikas with data upon Hungarian paprikas, and the Spanish pimentons with data upon Spanish pimentons.

It is shown that it is possible to distinguish by analytical methods and by characteristic properties, such as taste and odor, between the Hungarian paprikas and the Spanish pimentons. They have different uses, the pimenton being largely used for its coloring value, rather than for its flavor.

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